X5.03 - In Space Inspection Introduction

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NASA SBIR Program

- The **Small Business Innovation Research (SBIR) Program** was established by Congress in 1982 to provide increased opportunities for small businesses to participate in R&D, to increase employment, and to improve U.S. competitiveness. The program's specific objectives are to stimulate U.S. technological innovation, use small businesses to meet federal research and development needs, increase private-sector commercialization of innovations derived from federal R&D, and foster and encourage participation by socially disadvantaged businesses. Legislation enacted in 2000 extended and strengthened the SBIR program and increased its emphasis on pursuing commercial applications of SBIR project results.
- The **Small Business Technology Transfer (STTR) Program** awards contracts to small business concerns for cooperative research and development with a non-profit research institution (RI), such as a university. The goal of the Congress in establishing the STTR program is to facilitate the transfer of technology developed by an RI through the entrepreneurship of a small business. The small business and its partnering institution are required to sign an agreement on how intellectual property will be shared between them. Modeled after the SBIR Program with the same basic requirements and phased funding structure described above, STTR is nevertheless a separate activity and is separately funded. It differs from SBIR in several important aspects:
- Websites:

http://sbir.gsfc.nasa.gov/SBIR/SBIR.html

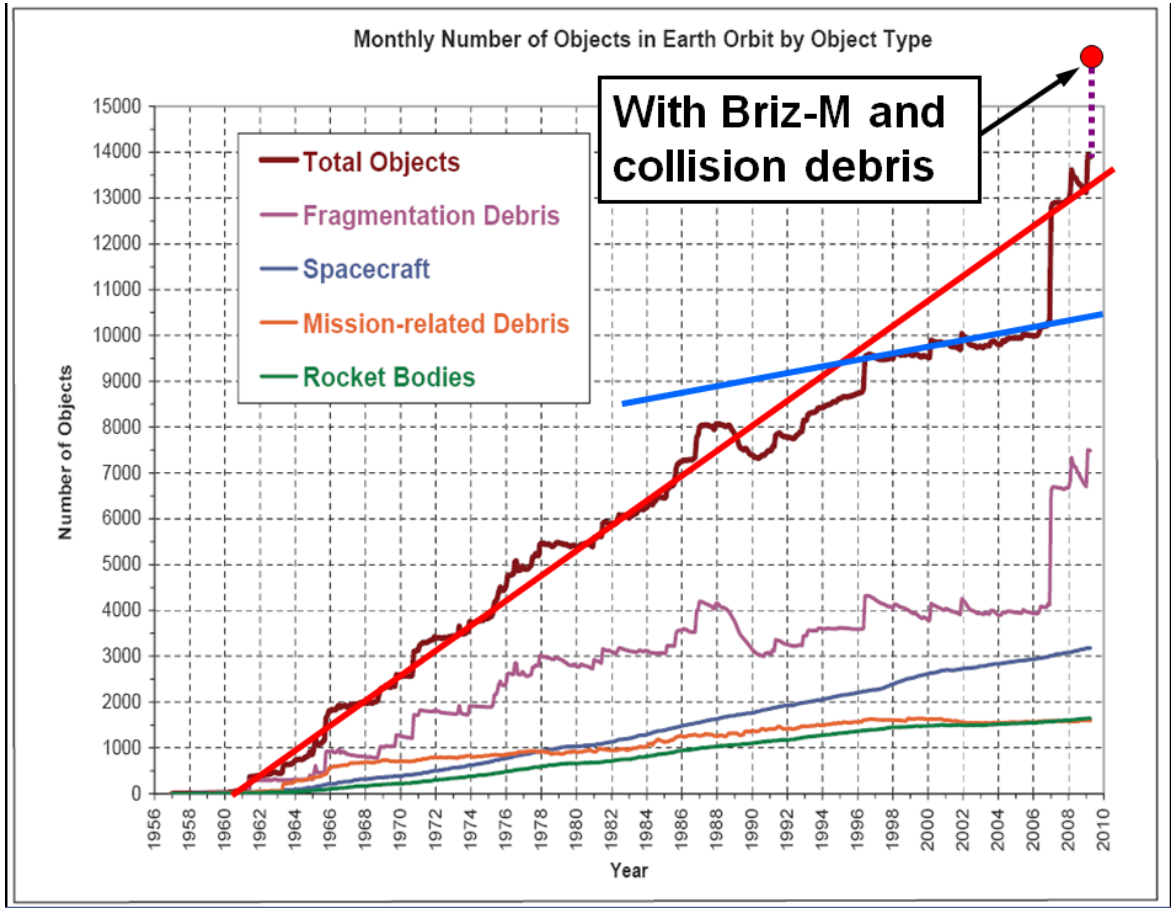
http://sbir.gsfc.nasa.gov/SBIR/proposer.html

Subtopic Narrative

There is a need for modular lightweight, low power multifunctional interrogation systems. These systems can that reduce or eliminate wiring. Smart in-situ sensor systems provide real time or as needed interrogation of complex material and structural systems. Systems developed under this subtopic are flexible in their applicability. These systems should allow for additional future changes in instrumentation late in the design/development process and enable relocation or upgrade on orbit. They reduce the complexities of standard wires and connectors and enable sensing functions in locations not normally accessible with previous technologies. They allow NASA to gain insight into performance and safety of NASA vehicles as well as commercial launchers, vehicles and payloads supporting NASA missions. The application of these systems could directly affect observations on the health of the thermal protection system and the ability of a space craft to perform primary functions like descent and landing.

Importance of Characterization of MMOD Impacts

- MMOD Impact currently accounts for an increasing risk of loss of crew and vehicle for capsule while on orbit.
- On orbit characterization of these impacts may be critical to determine the health of the vehicle post impacts.
- Inspection and damage criteria will also determine the worthiness of the vehicle to continue in deep space or enter a given atmospheric condition.
- A critical aspect of this study is on methods that could potentially be applied on-orbit or on mission.
- Using the chosen method should provide the ability to easily transition to a finite element model in order to run simulation given variable conditions.



Historical Growth of Space Debris Through 2009

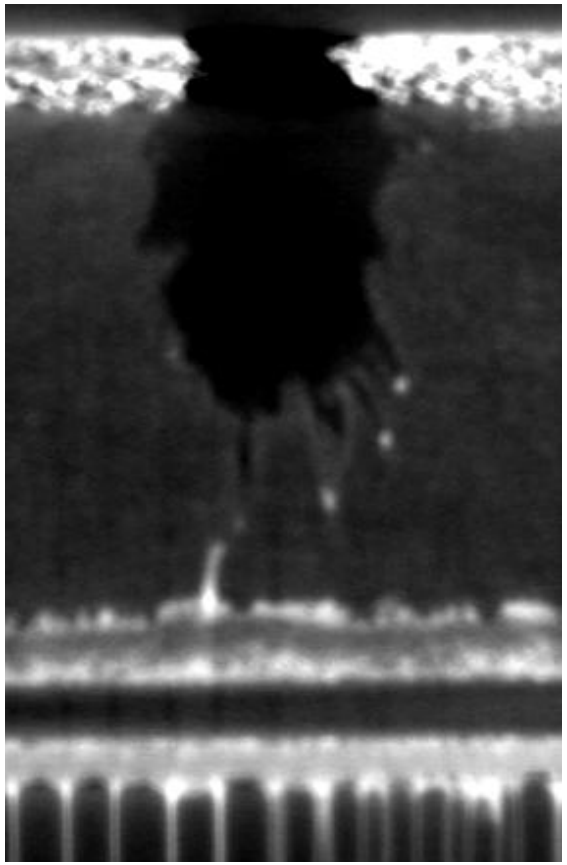
Main Areas of Interest

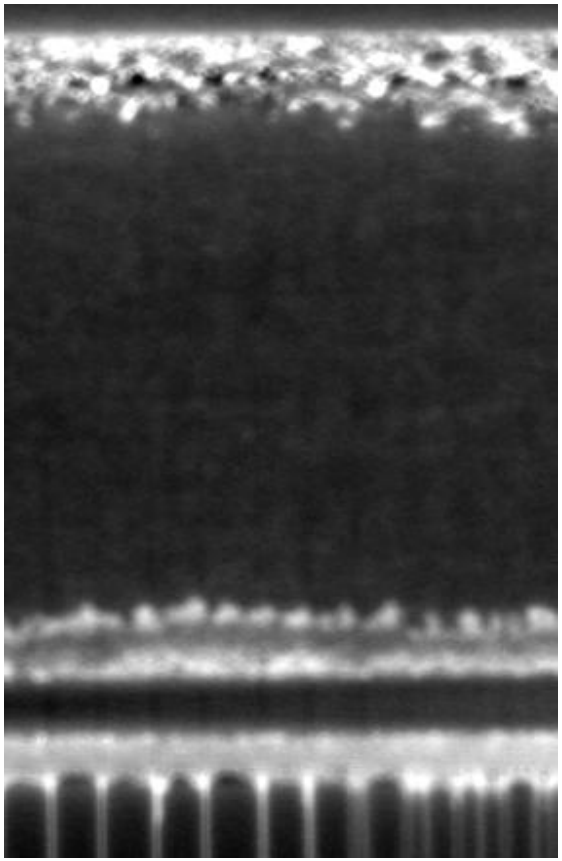
- In accordance with the Subtopic narrative NASA is looking for opportunities to partner with small business to develop several area of technology related to in space nondestructive evaluation. These include but are not limited to.
  - Though the thickness inspection techniques that can operate in the extreme regions of space. These conditions can include cryogenic temperatures and high radiation flux.
  - Inspection hardware should be lightweight, low volume and low power to meet the International Space Station and deep space power and weight requirements.
  - Inspection techniques should be capable of providing pseudo volumetric information on the space station or deep space thermal shielding systems either through direct or indirect inspection.
  - Structural health monitoring (SHM) is another area of interest including but not limited to hypervelocity impact detection and location.
  - Wireless communication and integration. This can be coupled with a relevant SHM system or to transmit sensor data from the damage location for storage and analysis.

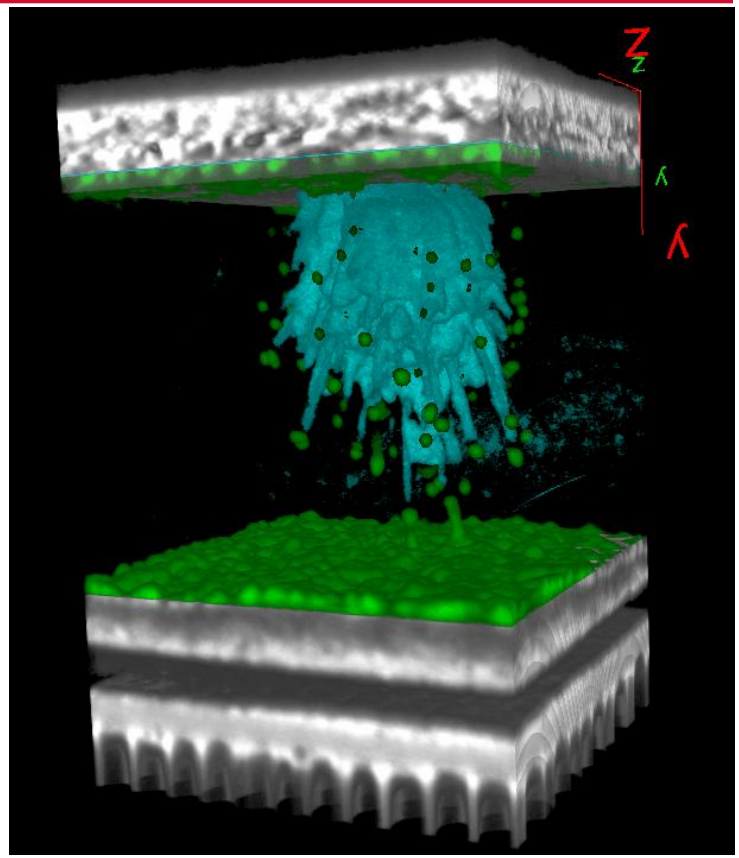
AETB-8 Single Tile - Background

- Damage characteristics:
  - Damage size on the exterior of the tile
  - Maximum cavity size
  - Cavity depth
  - Maximum damage depth
  - Extent of damage to strain isolation pad
  - Extent of damage to structural substrate.
- Impactor Details:
  - Impact 1: Hitf 09189
    - Dia:0.16 cm
    - Mass: 0.00597g
    - Velocity: 7Km/s
    - Angle:0.0
  - Impact 2: Hitf 09190
    - Dia:0.318 cm
    - Mass: 0.04704g
    - Velocity: 3.5Km/s
    - Angle:45
  - Impact 3: Hitf 09191
    - Dia:0.10 cm
    - Mass: 0.00405g
    - Velocity: 4Km/s
    - Angle:45

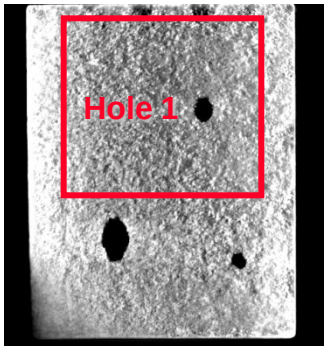
Impact 1



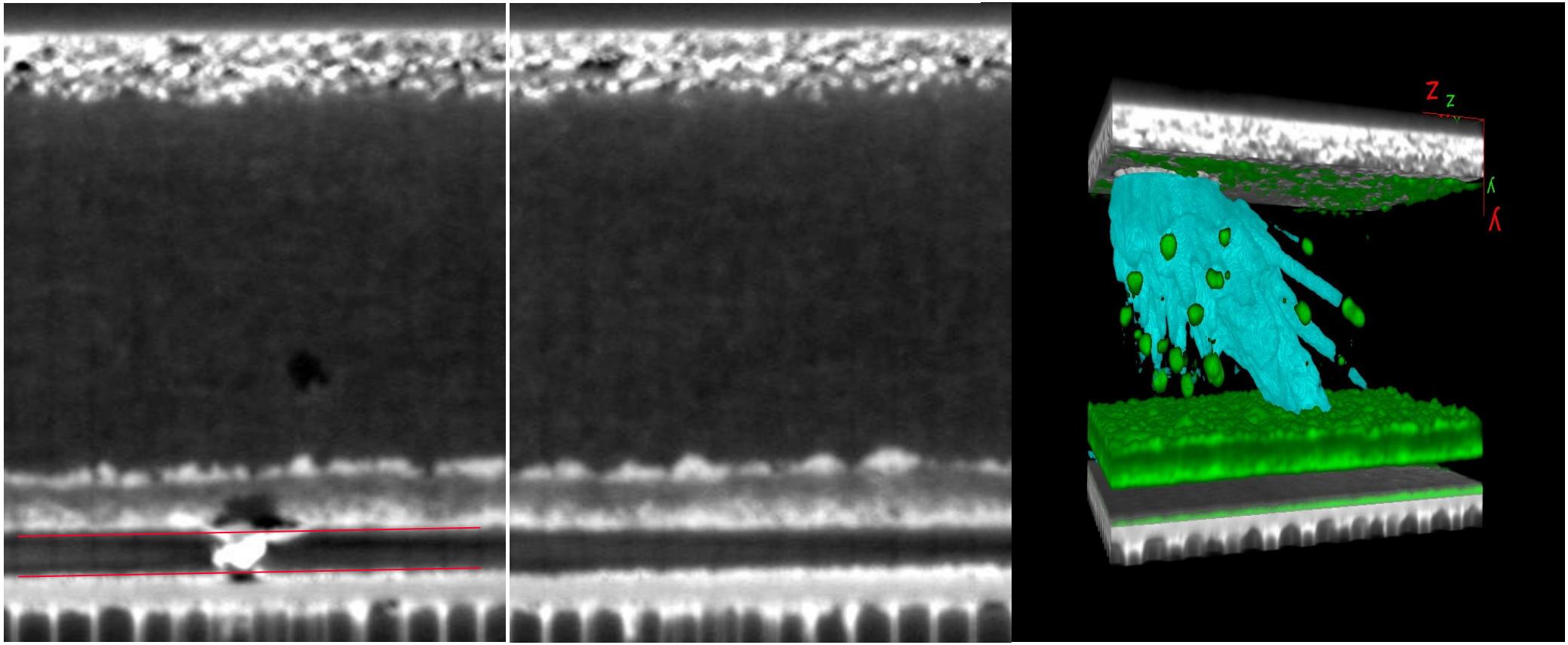




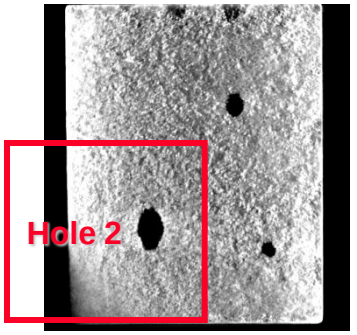
- Volumetric data can be viewed in several different ways.
- The deepest particle does not appear to exit the lower tile surface. Image shown here is slice 103 of a 282 in Indication 1 Sub-volume.
- Right image depicts the impact volume (Cyan) and embedded particle and substrate layers (Green) in 3 dimensions.



Impact 2

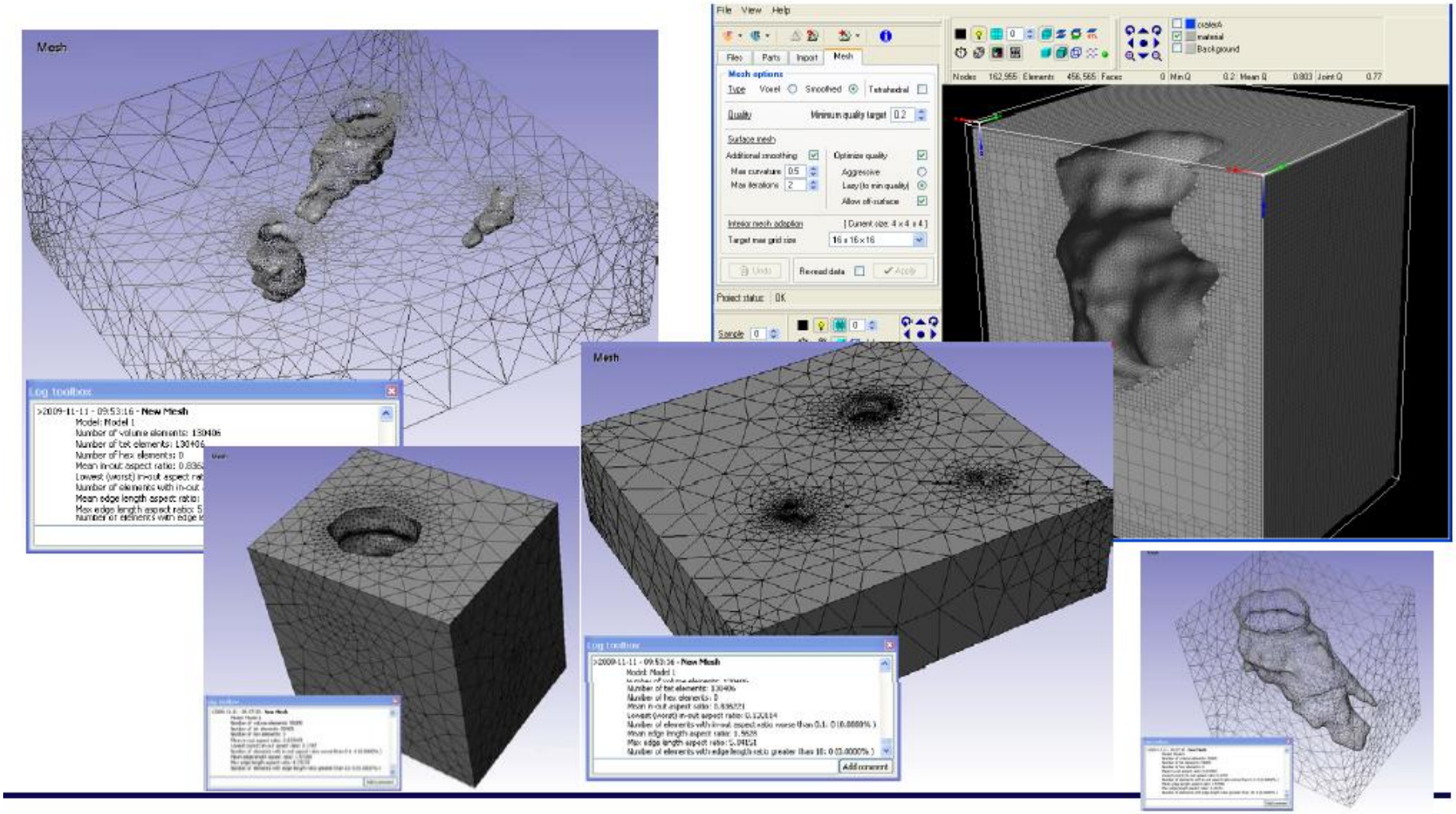


- The deepest particle does appear to exit the lower tile surface and damage the underlying substrate layer. Image shown here is slice 148 of a 432 in Indication 2 Sub-volume.
- Right image depicts the impact volume (Cyan) and embedded particle and substrate layers (Green) in 3 dimensions.



Export X-ray or THz CT data to STL and FE Models

- STL → For SimCT Model Validation / Comparison with Experimental Results
- FE → E.g., for Thermal analysis upon re-entry following impact damage using actual damage



Past Awards

- **2011**

  Phase 1:

  – Invocon – Hyper Velocity Impact Damage Assessment - Doug Heermann

  – Physical Optics Corporation - Structural Integrity Inspection and Visualization System - Victor Grubsky

  Phase 2:

  – Awards have not been made public yet

- **2010**

  Phase 1:

  – Radiation Monitoring Devices, Inc. - Wireless, Low Mass, High Sensitivity Sensing Sheet for Structural Sensing and Long Term Analysis - Timothy Tiernan

  – MaXentric Technologies - Spaceflight Structural Sensor Systems and NDE - Houman Ghajari

  – JENTEK Sensors, Inc. - NDE and Stress Monitoring on Composite Overwrapped Pressure Vessels - David Jablonski

  – Mnemonics, Inc. - Wireless SAW Interrogator & Sensor System - Mark Haines

  – Xigen, LLC - Novel Ultra-Miniature Flexible Videoscope for On-Orbit NDE - Jason Geng

  Phase 2:

  – Picometrix, LLC - Miniaturized Time Domain Terahertz Non Destructive Evaluation for In-Orbit Inspection of Inflatable Habitats and Thermal Protection Systems - David Zimdars